



July 30, 2019

Mr. Eric Cornwell
Program Manager
Stationary Source Permitting
Georgia EPD - Air Protection Branch
4244 International Parkway, Suite 120
Atlanta, Georgia 30354-3906

Subject: SIP Permit Application
Sterigenics, Atlanta Facility - Permit No. 7389-067-0093-S-05-0
AIRS Number 04-13-067-00093

Dear Mr. Cornwell:

Please find enclosed the SIP application for an emission reduction project at the Sterigenics US LLC Atlanta Facility located at 2971 Olympic Industrial Drive in Atlanta, Georgia. Sterigenics requests to expedite this application process if possible.

If you have any questions regarding this submittal, please call me at (630) 928-1724.

Sincerely,

Laura Hartman
Manager Environment, Health and Safety

Enclosures:

1. Expedited Permitting Program Application
2. SIP Air Permit Application Forms 1.00, 2.00, 2.06, 3.00, 4.00, 5.00, 6.00, and 7.00
3. Attachments A-F

copy: Daryl Mosby, Atlanta Facility General Manager



EXPEDITED PERMITTING PROGRAM – APPLICATION FOR ENTRY TO PROGRAM FOR AIR PERMITS

EPD Use Only

Date Received: _____ Application No. _____

To be eligible for expedited review, this application form must be accompanied by the complete permit application for the type of air permit being requested, and a pre-application meeting with EPD must have been conducted.

1. Contact Information

Facility Name: Sterigenics Atlanta Facility
AIRS No. (if known): 04-13- 067 - 00093
Contact Person: Laura Hartman Title: EHS Manager
Telephone No.: 630-928-1724 Alternate Phone No.: _____
Email Address: lhartman@sterigenics.com

If EPD is unable to contact me, please contact the alternate contact person:

Contact Person: Kevin Wagner Title: Director, EH&S
Telephone No.: 630-928-1771 Alternate Phone No.: _____
Email Address: KWagner@sterigenics.com

On Page 2 of this form, please check the appropriate box for which type of air permit you are requesting expedited review.

I have read the Expedited Review Program Standard Operating Procedures and accept all of the terms and conditions within. I understand that it is my responsibility to ensure an application of the highest quality is submitted and to address any requests for additional information by the deadline specified. I understand that submittal of this request form is not a guarantee that expedited review will be granted.

Signature: Laura Hartman Date: 30 July 2019

2. Applying For Which Type Of Permit: (Please Check Appropriate Box)

Expedited Review Fees for Air Permits	
<u>Permit Type – Please Check One</u>	<u>Expedited Review Fee</u>
<input type="checkbox"/> Generic Permit: Concrete Batch Plant – Minor Source	\$1,000
<input type="checkbox"/> Generic Permit: Concrete Batch Plant – Synthetic Minor Source	\$1,500
<input type="checkbox"/> Generic Permit: Hot Mix Asphalt Plant – Synthetic Minor Source	\$2,000
<input type="checkbox"/> Minor Source Permit (or Amendment)	\$3,000
<input checked="" type="checkbox"/> Synthetic Minor Permit (or Amendment)	\$4,000
<input type="checkbox"/> Major Source SIP Permit not subject to PSD or 112(g)	\$6,000
<input type="checkbox"/> Title V 502(b)(10) Permit Amendment	\$4,000
<input type="checkbox"/> Title V Minor Modification with Construction	\$4,000
<input type="checkbox"/> Title V Significant Modification	\$6,000
<input type="checkbox"/> Major Source SIP Permit subject to 112(g) but not subject to PSD	\$15,000
<input type="checkbox"/> PSD Permit (or Amendment) not subject to NAAQS and/or PSD Increment Modeling	\$15,000
<input type="checkbox"/> PSD Permit (or Amendment) subject to NAAQS and/or PSD Increment Modeling but not subject to Modeling for PM _{2.5} , NO ₂ , or SO ₂	\$20,000
<input type="checkbox"/> PSD Permit (or Amendment) subject to NAAQS and/or PSD Increment Modeling for PM _{2.5} , NO ₂ , or SO ₂	\$25,000
<input type="checkbox"/> PSD Permit (or Amendment) subject to NAAQS and/or PSD Increment Modeling for PM _{2.5} , NO ₂ , or SO ₂ and also impacting a Class I Area	\$30,000
<p>* Do not send fee payment with this form. Upon acceptance of application for the expedited permit program, EPD will notify you by phone. Fees must be paid via check to "Georgia Department of Natural Resources" within five (5) business days of acceptance.</p>	

3. Comments.

This section is optional. Applicants may use this field to include specific comments or requests for EPD consideration. For example, the applicant may use this field to request a public hearing or to remind EPD of review time needs and/or expectations that may differ from the time frames in the procedures.



SIP AIR PERMIT APPLICATION

EPD Use Only

Date Received: _____ Application No. _____

FORM 1.00: GENERAL INFORMATION

1. Facility Information

Facility Name: Sterigenics US LLC
AIRS No. (if known): 04-13- 067 - 00093
Facility Location: Street: 2971 Olympic Industrial Drive SE, Suite 116
City: Atlanta Georgia Zip: 30339 County: Cobb
Is this facility a "small business" as defined in the instructions? Yes: ☐ No: ☒

2. Facility Coordinates

Latitude: ° ' " NORTH Longitude: ° ' " WEST
UTM Coordinates: 734,200 EAST 3,746,411 NORTH ZONE 16

3. Facility Owner

Name of Owner: Sterigenics US LLC
Owner Address Street: 2015 Spring Road, Suite 650
City: Oak Brook State: IL Zip: 60523

4. Permitting Contact and Mailing Address

Contact Person: Laura Hartman Title: EHS Manager
Telephone No.: 630-928-1724 Ext. _____ Fax No.: 630-928-1701
Email Address: LHartman@sterigenics.com
Mailing Address: Same as: Facility Location: ☐ Owner Address: ☒ Other: ☐
If Other: Street Address: _____
City: _____ State: _____ Zip: _____

5. Authorized Official

Name: Kathleen Hoffman Title: Sr Vice President of EH&S
Address of Official Street: 2015 Spring Road Suite 650
City: Oak Brook State: IL Zip: 60523

This application is submitted in accordance with the provisions of the Georgia Rules for Air Quality Control and, to the best of my knowledge, is complete and correct.

Signature: KA Hoffman Date: 30-Jul-2019

6. Reason for Application: (Check all that apply)

- ☐ New Facility (to be constructed)
 ☐ Revision of Data Submitted in an Earlier Application
☒ Existing Facility (initial or modification application)
 Application No.: _____
☒ Permit to Construct
 Date of Original Submittal: _____
☒ Permit to Operate
☐ Change of Location
☒ Permit to Modify Existing Equipment:
 Affected Permit No.: 7389-067-0093-S-05

7. Permitting Exemption Activities (for permitted facilities only):

Have any exempt modifications based on emission level per Georgia Rule 391-3-1-.03(6)(i)(3) been performed at the facility that have not been previously incorporated in a permit?

- ☒ No
 ☐ Yes, please fill out the SIP Exemption Attachment (See Instructions for the attachment download)

8. Has assistance been provided to you for any part of this application?

- ☐ No
 ☐ Yes, SBAP
 ☒ Yes, a consultant has been employed or will be employed.

If yes, please provide the following information:

Name of Consulting Company: Ramboll
 Name of Contact: Joseph Hower
 Telephone No.: (213) 943-6319 Fax No.: _____
 Email Address: JHower@ramboll.com
 Mailing Address: Street: 350 South Grand Avenue Suite 2800
 City: Los Angeles State: CA Zip: 90071

Describe the Consultant's Involvement:

9. Submitted Application Forms: Select only the necessary forms for the facility application that will be submitted.

No. of Forms	Form
2	2.00 Emission Unit List
	2.01 Boilers and Fuel Burning Equipment
	2.02 Storage Tank Physical Data
	2.03 Printing Operations
	2.04 Surface Coating Operations
	2.05 Waste Incinerators (solid/liquid waste destruction)
2	2.06 Manufacturing and Operational Data
1	3.00 Air Pollution Control Devices (APCD)
	3.01 Scrubbers
	3.02 Baghouses & Other Filter Collectors
	3.03 Electrostatic Precipitators
1	4.00 Emissions Data
1	5.00 Monitoring Information
1	6.00 Fugitive Emission Sources
1	7.00 Air Modeling Information

10. Construction or Modification Date

Estimated Start Date: 9/1/2019

11. If confidential information is being submitted in this application, were the guidelines followed in the "Procedures for Requesting that Submitted Information be treated as Confidential"?

☐ No ☐ Yes ☒ N/A

12. New Facility Emissions Summary

Criteria Pollutant	New Facility	
	Potential (tpy)	Actual (tpy)
Carbon monoxide (CO)		
Nitrogen oxides (NOx)		
Particulate Matter (PM) (filterable only)		
PM <10 microns (PM10)		
PM <2.5 microns (PM2.5)		
Sulfur dioxide (SO ₂)		
Volatile Organic Compounds (VOC)		
Greenhouse Gases (GHGs) (in CO ₂ e)		
Total Hazardous Air Pollutants (HAPs)		
Individual HAPs Listed Below:		

13. Existing Facility Emissions Summary

Criteria Pollutant	Current Facility		After Modification	
	Potential (tpy)	Actual (tpy)	Potential (tpy)	Actual (tpy)
Carbon monoxide (CO)	<10	0.9	<10	
Nitrogen oxides (NOx)	<25	1.1	<25	
Particulate Matter (PM) (filterable only)	<100	0.1	<100	
PM <10 microns (PM10)	<100	0.1	<100	
PM <2.5 microns (PM2.5)	<100	0.1	<100	
Sulfur dioxide (SO ₂)	<250	0.01	<250	
Volatile Organic Compounds (VOC)	<10	0.1	<10	
Greenhouse Gases (GHGs) (in CO ₂ e)				
Total Hazardous Air Pollutants (HAPs)	<10		<10	0.019
Individual HAPs Listed Below:				
Ethylene Oxide	3.28	0.13	0.187	0.019
Propylene Oxide	0.13	0.0005	0.01	0.00007

14. 4-Digit Facility Identification Code:

SIC Code: 7389 SIC Description: Business Services Not Elsewhere Classified
NAICS Code: 561910 NAICS Description: Packaging and Labeling – Product Sterilization

15. Description of general production process and operation for which a permit is being requested. If necessary, attach additional sheets to give an adequate description. Include layout drawings, as necessary, to describe each process. References should be made to source codes used in the application.

Sterigenics operates a commercial sterilization facility in Atlanta, Georgia. Please see attached for a description of the sterilization process and proposed changes.

16. Additional information provided in attachments as listed below:

Attachment A - Description of Process and Proposed Improvements to Emissions Capture and Control System
Attachment B - Plot Plan
Attachment C - Flow Diagram
Attachment D - Emission Calculations
Attachment E - Additional Data on production throughput estimate
Attachment F - Modeling Data

17. Additional Information: Unless previously submitted, include the following two items:

- ☒ Plot plan/map of facility location or date of previous submittal: _____
☒ Flow Diagram or date of previous submittal: _____

18. Other Environmental Permitting Needs:

Will this facility/modification trigger the need for environmental permits/approvals (other than air) such as Hazardous Waste Generation, Solid Waste Handling, Water withdrawal, water discharge, SWPPP, mining, landfill, etc.?

☒ No ☐ Yes, please list below: _____

19. List requested permit limits including synthetic minor (SM) limits.

20. Effective March 1, 2019, permit application fees will be assessed. The fee amount varies based on type of permit application. Application acknowledgement emails will be sent to the current registered fee contact in the GECO system. If fee contacts have changed, please list that below:

Fee Contact name:

Fee Contact email address:

Fee Contact phone number:

Fee invoices will be created through the GECO system shortly after the application is received. It is the applicant's responsibility to access the facility GECO account, generate the fee invoice, and submit payment within 10 days after notification.

Facility Name: Sterigenics Atlanta Facility

Date of Application: 30 July 2019

FORM 2.00 – EMISSION UNIT LIST

Emission Unit ID	Name	Manufacturer and Model Number	Description
SEV-1	Chamber 1 vacuum pump	Existing	Six-pallet Sterilization Chamber 1 vacuum pump
SEV-2	Chamber 2 vacuum pump	Existing	Six-pallet Sterilization Chamber 2 vacuum pump
SEV-3	Chamber 3 vacuum pump	Existing	Nine-pallet Sterilization Chamber vacuum pump
SEV-4	Chamber 4 vacuum pump	Existing	Five-pallet Sterilization Chamber vacuum pump
SEV-5	Chamber 5 vacuum pump	Existing	Thirteen-pallet Sterilization Chamber vacuum pump
SEV-6	Chamber 6 vacuum pump	Existing	Thirteen-pallet Sterilization Chamber vacuum pump
SEV-7	Chamber 7 vacuum pump	Existing	Thirteen-pallet Sterilization Chamber vacuum pump
SEV-8	Chamber 8 vacuum pump	Existing	Thirteen-pallet Sterilization Chamber vacuum pump
SEV-10	Chamber 10 vacuum pump	Existing	Thirty-pallet Sterilization Chamber vacuum pump
SEV-11	Chamber 11 vacuum pump	Existing	Thirty-pallet Sterilization Chamber vacuum pump
CEV-1	Backvent for Chamber 1	Existing	Backvent for Chamber 1
CEV-2	Backvent for Chamber 2	Existing	Backvent for Chamber 2
CEV-3	Backvent for Chamber 3	Existing	Backvent for Chamber 3
CEV-4	Backvent for Chamber 4	Existing	Backvent for Chamber 4
CEV-5	Backvent for Chamber 5	Existing	Backvent for Chamber 5
CEV-6	Backvent for Chamber 6	Existing	Backvent for Chamber 6
CEV-7	Backvent for Chamber 7	Existing	Backvent for Chamber 7
CEV-8	Backvent for Chamber 8	Existing	Backvent for Chamber 8
CEV-10	Backvent for Chamber 10	Existing	Backvent for Chamber 10

Facility Name: Sterigenics Atlanta Date of Application: 30 July 2019

FORM 2.06 – MANUFACTURING AND OPERATIONAL DATA

Normal Operating Schedule: 24 hours/day 7 days/week 52 weeks/yr

Additional Data Attached? ☐ - No ☒ - Yes, please include the attachment in list on Form 1.00, Item 16.

Seasonal and/or Peak Operating Periods: N/A

Dates of Annually Occurring Shutdowns: N/A

PRODUCTION INPUT FACTORS

Emission Unit ID	Emission Unit Name	Const. Date	Input Raw Material(s)	Annual Input	Hourly Process Input Rate		
					Design	Normal	Maximum
SEV-1	Chamber 1 vacuum pump	1967	Ethylene Oxide Propylene Oxide	12.9 tpy 0.5 tpy		2.9 lb 0.1 lb	
SEV-2	Chamber 2 vacuum pump	1967	Ethylene Oxide Propylene Oxide	12.9 tpy 0.5 tpy		2.9 lb 0.1 lb	
SEV-3	Chamber 3 vacuum pump	1967	Ethylene Oxide Propylene Oxide	19.4 tpy 0.8 tpy		4.4 lb 0.2 lb	
SEV-4	Chamber 4 vacuum pump	1967	Ethylene Oxide Propylene Oxide	10.8 tpy 0.4 tpy		2.5 lb 0.1 lb	
SEV-5	Chamber 5 vacuum pump	1987	Ethylene Oxide Propylene Oxide	28.0 tpy 1.1 tpy		6.4 lb 0.3 lb	
SEV-6	Chamber 6 vacuum pump	1992	Ethylene Oxide Propylene Oxide	28.0 tpy 1.1 tpy		6.4 lb 0.3 lb	
SEV-7	Chamber 7 vacuum pump	1994	Ethylene Oxide Propylene Oxide	28.0 tpy 1.1 tpy		6.4 lb 0.3 lb	
SEV-8	Chamber 8 vacuum pump	1994	Ethylene Oxide Propylene Oxide	28.0 tpy 1.1 tpy		6.4 lb 0.3 lb	
SEV-10	Chamber 10 vacuum pump	2014	Ethylene Oxide Propylene Oxide	64.5 tpy 2.6 tpy		14.7 lb 0.6 lb	
SEV-11	Chamber 11 vacuum pump	2015	Ethylene Oxide Propylene Oxide	64.5 tpy 2.6 tpy		14.7 lb 0.6 lb	
CEV-1	Chamber 1 Backvent	1967	Ethylene Oxide Propylene Oxide	0.1 tpy 0.005 tpy		0.03 lb 0.001 lb	
CEV-2	Chamber 2 Backvent	1967	Ethylene Oxide Propylene Oxide	0.1 tpy 0.005 tpy		0.03 lb 0.001 lb	
CEV-3	Chamber 3 Backvent	1967	Ethylene Oxide Propylene Oxide	0.2 tpy 0.008 tpy		0.05 lb 0.002 lb	

PRODUCTS OF MANUFACTURING

Emission Unit ID	Description of Product	Production Schedule		Hourly Production Rate (Give units: e.g. lb/hr, ton/hr)			
		Tons/yr	Hr/yr	Design	Normal	Maximum	Units

Facility Name: Sterigenics Atlanta Facility Date of Application: 30 July 2019

FORM 2.06 – MANUFACTURING AND OPERATIONAL DATA

Normal Operating Schedule: 24 hours/day 7 days/week 52 weeks/yr

Additional Data Attached? ☐ - No ☒ - Yes, please include the attachment in list on Form 1.00, Item 16.

Seasonal and/or Peak Operating Periods: N/A

Dates of Annually Occurring Shutdowns: N/A

PRODUCTION INPUT FACTORS

Emission Unit ID	Emission Unit Name	Const. Date	Input Raw Material(s)	Annual Input	Hourly Process Input Rate		
					Design	Normal	Maximum
CEV-4	Chamber 4 Backvent	1967	Ethylene Oxide Propylene Oxide	0.1 tpy 0.005 tpy		0.03 lb 0.001 lb	
CEV-5	Chamber 5 Backvent	1987	Ethylene Oxide Propylene Oxide	0.3 tpy 0.01 tpy		0.07 lb 0.003 lb	
CEV-6	Chamber 6 Backvent	1992	Ethylene Oxide Propylene Oxide	0.3 tpy 0.01 tpy		0.07 lb 0.003 lb	
CEV-7	Chamber 7 Backvent	1994	Ethylene Oxide Propylene Oxide	0.3 tpy 0.01 tpy		0.07 lb 0.003 lb	
CEV-8	Chamber 8 Backvent	1994	Ethylene Oxide Propylene Oxide	0.3 tpy 0.01 tpy		0.07 lb 0.003 lb	
CEV-10	Chamber 10 Backvent	2014	Ethylene Oxide Propylene Oxide	0.7 tpy 0.03 tpy		0.07 lb 0.003 lb	
CEV-11	Chamber 11 Backvent	2015	Ethylene Oxide Propylene Oxide	0.7 tpy 0.03 tpy		0.16 lb 0.01 lb	
AR-1	Aeration Room 1		Ethylene Oxide Propylene Oxide	12.5 tpy 0.5 tpy		2.9 lb 0.01 lb	
SR-1	Spice Room	new	Ethylene Oxide	0.02 tpy		0.005 lb	
IA-1	Indoor Air capture	new	Ethylene Oxide Propylene Oxide	0.2 tpy 0.01 tpy		0.04 lb 0.001 lb	

PRODUCTS OF MANUFACTURING

Emission Unit ID	Description of Product	Production Schedule		Hourly Production Rate (Give units: e.g. lb/hr, ton/hr)			
		Tons/yr	Hr/yr	Design	Normal	Maximum	Units

Date of Application: 30 July 2019

[illegible]

Date of Application: 30 July 2019

[illegible]

30 July 2019

[illegible]

Facility Name: Sterigenics Atlanta Facility

Date of Application: 30 July 2019

FORM 5.00 MONITORING INFORMATION

Emission Unit ID/ APCD ID	Emission Unit/APCD Name	Monitored Parameter		Monitoring Frequency
		Parameter	Units	
EC2	AAT Scrubber with dry beds	Control efficiency or outlet concentration	percent removal or ppm	Weekly
EC2	AAT Scrubber with dry beds	Scrubber liquor level	inches	daily
EC2	AAT Scrubber with dry beds	Scrubber liquor pH	pH	daily
EC3	Ceilcote Scrubber	Scrubber liquor level	inches	daily
EC3	Ceilcote Scrubber	Scrubber liquor pH	pH	daily
EC4	New Dry Bed	Control efficiency or outlet concentration	percent removal or ppm	Weekly

Comments:

Facility Name: Sterigenics Atlanta Facility Date of Application: 30 July 2019

FORM 6.00 – FUGITIVE EMISSION SOURCES

[illegible]

Date of Application: 30 July 2019

[illegible]

Attachment A

DESCRIPTION OF PROCESS AND PROPOSED IMPROVEMENTS TO EMISSIONS CAPTURE AND CONTROL SYSTEMS

This application addresses improvements to the Atlanta facility located at 2971 Olympic Industrial Drive SE, Suite 116, Atlanta, Georgia. Sterigenics is voluntarily requesting to add control devices and improve control efficiencies of certain emission sources. These additional controls currently are not required by Georgia EPD or the UESPA, but the company has determined that it can reduce emissions further.

Overview of Sterigenics Atlanta Facility

Sterigenics operates a commercial contract sterilization facility in Atlanta, GA. This application addresses improvements to the emission control measures at the Atlanta facility.

Sterigenics' Atlanta facility utilizes ethylene oxide to sterilize customers' product. It also has the ability to use propylene oxide to treat nutmeats and a cosmetic ingredient. Ethylene oxide and propylene oxide are sterilants that regulatory agencies such as the U.S. Food and Drug Administration and U.S. Environmental Protection Agency (administering the Federal Insecticide, Fungicide, and Rodenticide Act) allow to be used on products. In addition, medical devices must meet a certain level of sterility as regulated by U.S. Food and Drug Administration and other regulatory agencies.

When ethylene oxide is used for medical device sterilization, the medical devices must have a specifically defined sterilization process, which is validated for a specific sterilization chamber or chambers. The Atlanta facility uses ten sterilization chambers ranging in size from 6 pallets up to 30 pallets. While all ten sterilization chambers are similar in design, each chamber may only process products approved for that chamber and cannot process other products that have not been validated and approved by the appropriate regulatory agency for that specific chamber.

As a contract sterilization facility, Atlanta sterilizes many different products from many different customers.

Purpose of Project

The purpose of the project is to further reduce ethylene oxide emissions from the sterilization process by adding additional controls; this project is being undertaken voluntarily, even though the facility is and has historically been in compliance with existing regulations and permit conditions. Sterigenics is not proposing to change the actual sterilization process at the Atlanta facility.

Attachment A

Description of Sterilization Process

The Atlanta facility performs sterilization operations for many customers. Each product has specific requirements which specify details of the sterilization process to be followed.

Receiving and Pre-Conditioning

Customers ship packaged products to Sterigenics. Once the product is received, the sterilization process follows the same flow through the facility. The first step after receipt of the product is to place the product into a preconditioning room. Preconditioning rooms are enclosed rooms which are heated and maintained at high humidity to prepare the product for sterilization. The product is in the preconditioning room for the time required for the specific product. No ethylene oxide is introduced or present in this step of the process.

Once preconditioning is complete, the product is moved to the appropriate sterilization chamber. There are ten sterilization chambers. A chamber is sized based on the number of pallets that it can hold and range from six pallets to thirty pallets. Once the product is loaded into the chamber, the chamber is closed and sealed. At the beginning of each sterilization cycle, safety checks are performed to ensure ethylene oxide does not escape from the chamber during the cycle. In addition, the cycle is monitored to ensure that vacuum is maintained within acceptable parameters.

Drum Storage

At Atlanta, ethylene oxide is stored in sealed drums in an outside storage area before use. The drums are U.S. Department of Transportation rated UN 1A1 containers. The storage area complies with the requirements of NFPA 55 Chapter 14 for an outside storage area. No dispensing takes place in the drum storage area. To dispense ethylene oxide, the drums are moved with a drum cart from the storage area to the dispensing stations located inside the chamber room area. Once in place at the dispensing station, the ethylene oxide drum is connected to the dispensing system for the specific sterilization chamber.

Chamber Operation, Vacuum Pump Emissions

As mentioned above, there is a validated cycle for each product. This validated cycle must meet specific regulatory requirements and will detail the times, parameters, and testing required for each product and the specific chamber approved. The sterilization process begins with evacuating the air from the chamber and introducing nitrogen. While under negative pressure inside the chamber, ethylene oxide is introduced into the sterilization chamber to sterilize the product. Once ethylene oxide is introduced, the dwell stage can last from 30 minutes up to several hours according to the validated cycle for the product. Once complete, the sterilization chamber vacuum pumps remove most of the ethylene oxide from the chamber by exhausting

Attachment A

and purging with nitrogen multiple times. Vacuum pump emissions are routed to the Ceilcote wet acid scrubber. The Ceilcote scrubber (EC3) currently is exhausted to a dedicated stack.

Backvents and Aeration Emissions

Once the sterilization chamber process is complete and the chamber door is partially opened, the back vent fan activates to extract residual amounts of ethylene oxide from the chamber. This fan remains on while the chamber door is open. After fifteen minutes, the pallets of product are removed from the sterilization chamber and placed into aeration rooms to further off-gas residual ethylene oxide. During spice fumigation, the chamber process includes additional gas washes to remove ethylene oxide from the product which eliminates the need for time in an aeration room. Both the backvents and aeration rooms are ducted to an existing AAT scrubber system and treated with 12 dry bed reactors (EC2). The AAT scrubber with dry beds currently exhausts to a dedicated stack.

Proposed Project Detail

This permit application proposes to make the following improvements to the existing capture and control equipment and to reduce the ethylene oxide emissions from the Atlanta facility. With these improvements, the facility will have technology that provides the greatest reduction in ethylene oxide emissions that is now available.

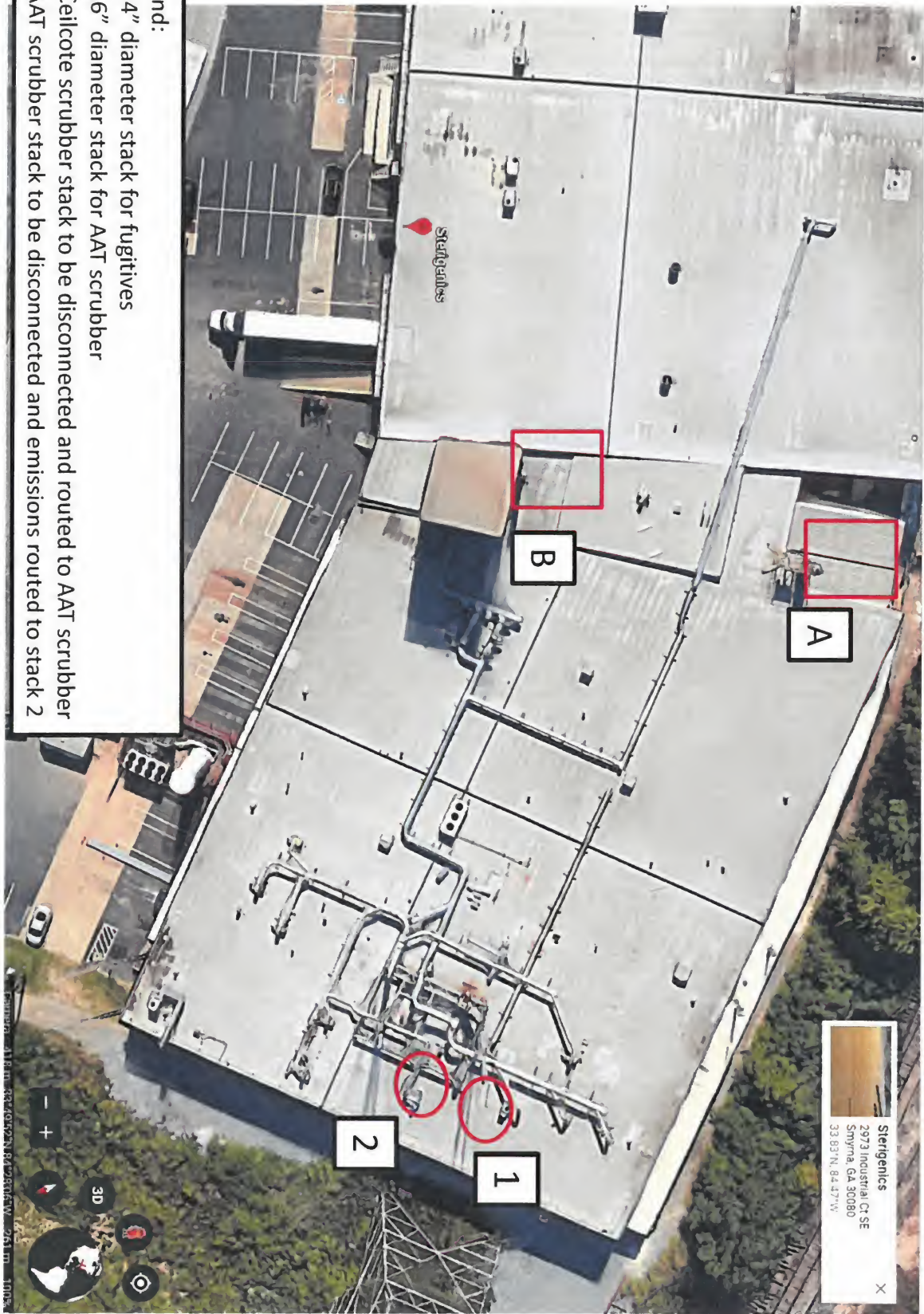
- 1) Currently the existing Atlanta Ceilcote scrubber (EC3) exhausts to atmosphere via a dedicated stack. Sterigenics proposes to duct the outlet of the Ceilcote Scrubber to the existing Advanced Air Technologies (AAT) scrubber with dry bed (EC2) to further reduce vacuum pump emissions.
- 2) Currently, the existing AAT scrubber with dry beds (EC2) exhausts to atmosphere via a dedicated stack. Sterigenics proposes to duct the outlet of the AAT scrubber with dry beds to a different existing stack measuring 80 feet tall and 16 inches in diameter. This stack exists but is currently not being used.
- 3) An additional negative pressure system is proposed to capture air internally from chamber rooms, work aisles, processed product storage, and shipping areas. With this negative pressure system, the facility will route the indoor air to a new dry bed control system consisting of 18 dry beds. These dry beds will exhaust to atmosphere via an existing stack measuring 80 feet tall and 2 feet in diameter.
- 4) In addition to these emission reduction projects, Sterigenics is proposing to build a room to be dedicated to storing treated spices after the fumigation process is complete. This spice room will be exhausted to the existing AAT scrubber system with dry beds (EC2).

Attachment A

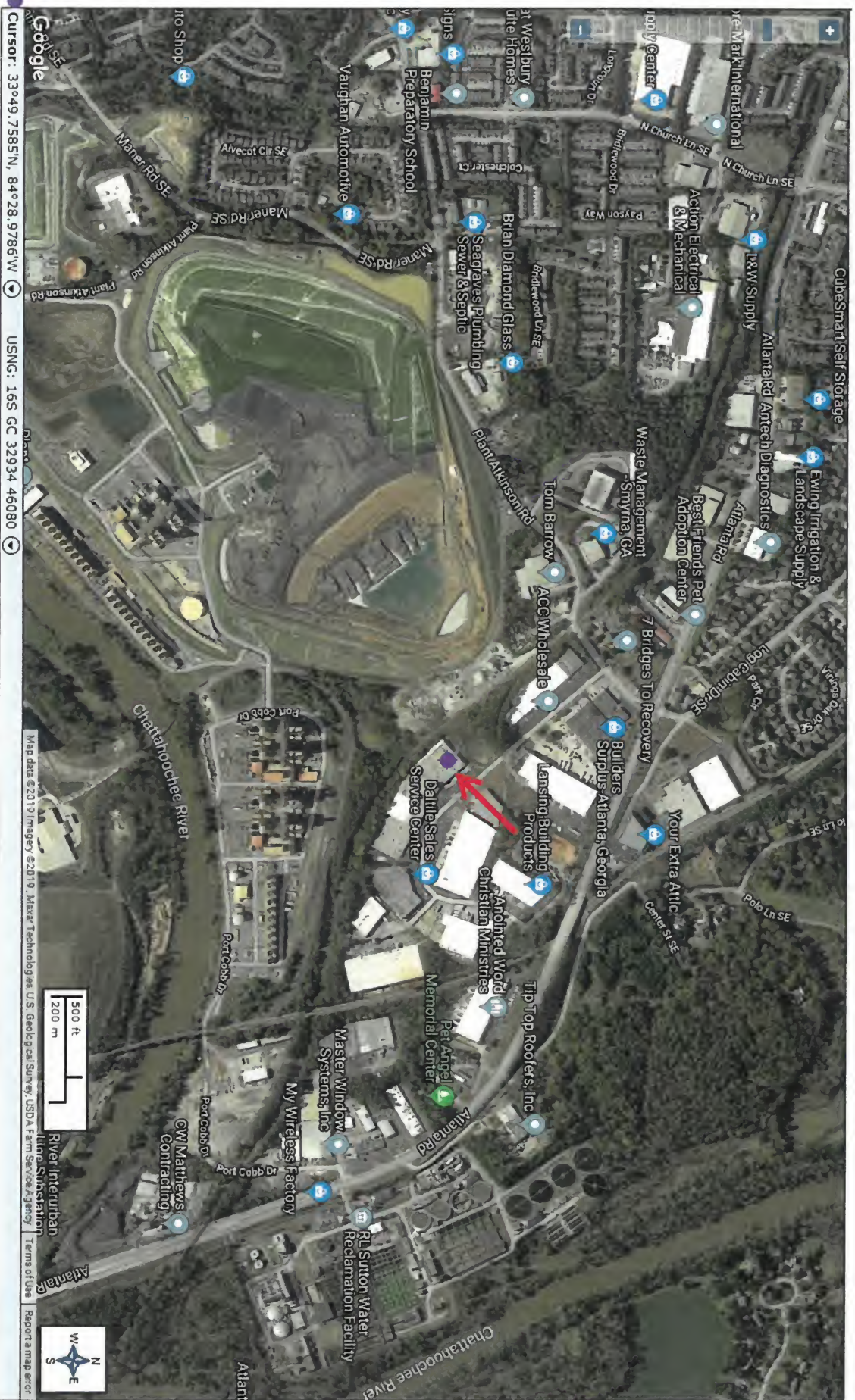
Control Efficiencies

The Ceilcote scrubber controls the sterilization chamber vacuum pump emissions. The Ceilcote scrubber has control efficiency greater than 99%. The AAT Scrubber with dry beds controls the aeration and back vent emissions. The AAT scrubber dry beds have a control efficiency greater than 99% destruction efficiency. This project is proposing to route the outlet of the Ceilcote scrubber to the AAT scrubber with dry beds.

Attachment B: Plot Plan



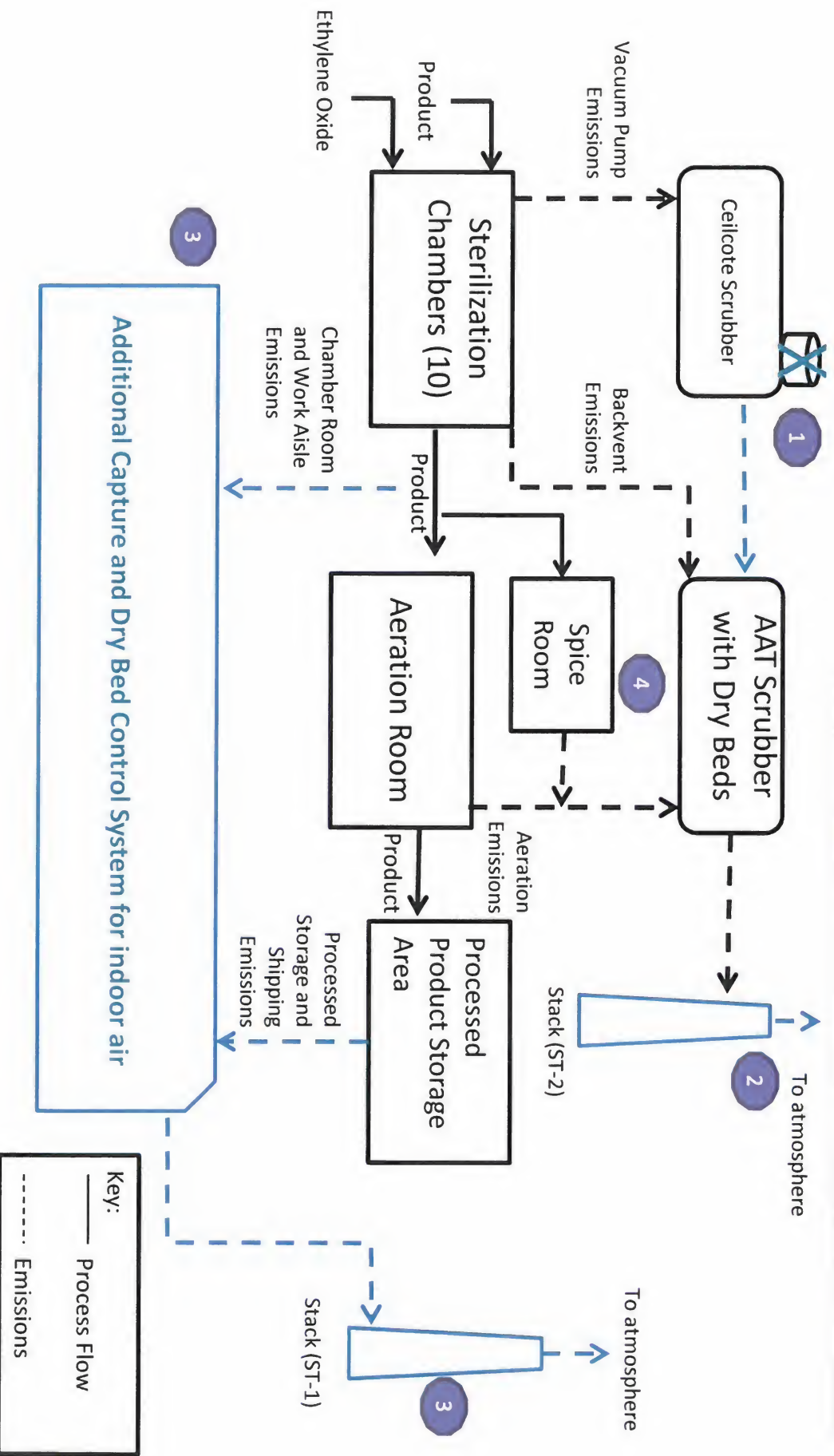
Attachment B: Plot Plan



● Sterigenics Atlanta location

Attachment C: Sterigenics Atlanta Process Flow Diagram (Changes noted in Blue)

- Additional Capture/Control Equipment:
- 1) Route Ceilcote emissions to AAT Scrubber and eliminate Ceilcote stack
 - 2) Route AAT scrubber to an 80 foot stack. Eliminate AAT stack.
 - 3) Installation of capture and control system for indoor air in processed areas and route to an 80 foot stack.
 - 4) Build a dedicated room for processed spices and duct to existing AAT scrubber.



Attachment D Emission Calculations

Existing Emission Controls			Proposed Emission Controls		
Control Devices	Required Existing Efficiency	Actual Existing Efficiency	Control Devices	Required Proposed Efficiency	Actual Expected Efficiency
Sterilizer Vacuum Pump			Celcote Scrubber and AAT	99.99%	99.999998%
Aeration Rooms	AAT System	99.0%	AAT System	99.0%	99.833%
Backvent	AAT System	99.0%	AAT System	99.0%	99.833%
Fugitives	None	0.0%	Dry Bed system (new)	99.0%	99.000%

	Existing			Proposed		
	Ethylene Oxide Potential (lbs)	Ethylene Oxide 2018 (lbs)	Propylene Oxide Potential (lbs)	Propylene Oxide 2018 (lbs)	Ethylene Oxide Expected (lbs) (2018)	Propylene Oxide Expected (lbs) (2018)
Usage (pounds)	625,000	425,000	25000	1569	625,000	425000
Sterilizer Emissions	5,937.5	4.04	237.5	0.0149	59.4	0.007
Aeration Emissions	250.00	28.39	10.00	0.10	250.0	28.4
Backvent Emissions	62.50	7.10	2.50	0.03	62.5	7.1
Fugitive Emissions	312.5	212.5	12.5	0.8	3.1	2.1
TOTAL Emissions	6,563	252	263	0.93	375.0	37.62
TOTAL Emissions (tons)	3.28	0.13	0.13	0.00047	0.187	0.019

Assumptions

95% Usage through Chamber Vacuum Pumps

4% Usage through Aeration

1% Usage through Back Vents

0.05% Usage Assumed as fugitives

Example Calculations:

Emission Source = (mass balance)(ETO usage)(1-efficiency %)

Sterilizer Emissions = $0.95 * 425000 * (1 - 0.99999) = 4.04\text{lbs}$

Aeration Emissions = $0.04 * 425000 * (1 - 0.99833) = 28.39\text{lbs}$

Backvent Emissions = $0.01 * 425000 * (1 - 0.99833) = 7.10\text{lbs}$

Fugitive Emissions = $0.0005 * 425000 = 212.5\text{lbs}$

Attachment E Additional Data on Production Throughput Estimate

Equipment	Pallet Size	Ethylene Oxide Usage lb/yr	Propylene Oxide Usage lb/yr	SEV Emission Units						CEV Emission Units					
				Annual Throughput		Average Hourly Process Input Rate		CEV Annual Throughput		Average Hourly Process Input Rate		Ethylene Oxide (lb/hr)	Propylene Oxide (lb/hr)	Ethylene Oxide (lb/hr)	Propylene Oxide (lb/hr)
				Ethylene Oxide (tpy)	Propylene Oxide (tpy)	Ethylene Oxide (lb/hr)	Propylene Oxide (lb/hr)	Ethylene Oxide (tpy)	Propylene Oxide (tpy)	Ethylene Oxide (lb/hr)	Propylene Oxide (lb/hr)				
Chamber 1	6	27174	1087	12.9	0.52	2.9	0.12	0.1	0.0054	0.03	0.0012				
Chamber 2	6	27174	1087	12.9	0.52	2.9	0.12	0.1	0.005	0.03	0.0012				
Chamber 3	9	40761	1630	19.4	0.77	4.42	0.18	0.2	0.008	0.05	0.0019				
Chamber 4	5	22645	906	10.8	0.43	2.46	0.10	0.1	0.005	0.03	0.0010				
Chamber 5	13	58877	2355	28.0	1.12	6.39	0.26	0.3	0.012	0.07	0.0027				
Chamber 6	13	58877	2355	28.0	1.12	6.39	0.26	0.3	0.012	0.07	0.0027				
Chamber 7	13	58877	2355	28.0	1.12	6.39	0.26	0.3	0.012	0.07	0.0027				
Chamber 8	13	58877	2355	28.0	1.12	6.39	0.26	0.3	0.012	0.07	0.0027				
Chamber 10	30	135870	5435	64.5	2.58	14.73	0.59	0.7	0.027	0.16	0.0062				
Chamber 11	30	135870	5435	64.5	2.58	14.73	0.59	0.7	0.027	0.16	0.0062				

Emission Unit	Annual Throughput		Average Hourly Process Input Rate		
	Ethylene Oxide (tpy)	Propylene Oxide (tpy)	Ethylene Oxide (lb/hr)	Propylene Oxide (lb/hr)	
AR-1 (Aeration Room 1)	12.5	0.50	2.9	0.1	
SR-1 (Spice Room 1)	0.02	0.00	0.005	0.0	
IA-1 (Indoor Air)	0.16	0.0063	0.036	0.0014	

Assumptions

Average EO lb/pallet/yr based on 625000 lb of EO 4529

Average PO lb/pallet/yr based on 25000 lb of PO 181

Chamber usage based on number of pallets. Actual throughput thru chamber may vary

95% of chemical from Chamber via SEV

1% of chemical from Chamber via CEV

4% of chemical via Aeration

Proposed Improvement Project includes the following elements:

- 1. Route vacuum pump emissions from the Celicote scrubber stack to the AAT scrubber, which will further reduce vacuum pump emissions by 99%
- 2. Route AAT stack emissions to one of the 80' roof stacks (16" diameter)
- 3. Install a fugitive emission capture system and route all indoor emissions through a new dry bed system. Emissions from the dry beds will be routed to the second 80' stack on the roof (24" diameter)

Ethylene Oxide (EO) Emissions

Emission Source	Estimated Annual EO Throughput (lb)	Efficiency	Estimated EO Emissions (lb/yr)
AAT Scrubber (5%)		99.8333%	35.49
Celicote (95%)	425,000	99.9990%	
Fugitives (0.05%)		99%	2.13

Model Input Parameters for EO Emissions Sources

Model ID	Stack Description	Source Type	UTM E ¹ (m)	UTM N ¹ (m)	Elevation ² (m)	Modeled ETO Emissions ³ (lb/s)	Stack Height		Stack Temperature		Exhaust Gas Flow Rate (scfm)	Exhaust Gas Flow Rate (acfm)	Exit Velocity		Stack Diameter	
							(ft)	(m)	(°F)	(K)			(ft/s)	(m/s)	(ft)	(m)
STK2	AAT Scrubber	POINT	734,200	3,746,411	250.92	5.11E-04	80.0	24.38	98	309.82	12,000	13.052,00	155.8	47.4869	1.3	0.406
STK1	Fugitives	POINT	734,194	3,746,406	250.58	3.06E-05	80.0	24.38	70	294.26	18,000	18.576,00	98.5	30.0377	2.0	0.610

Notes:

- 1. Coordinates are based on UTM MADO3, Zone 16.
- 2. Modeled elevations were incorporated using AERMAP version 18081. Terrain elevation data was obtained using the National Elevation Data (NED) files from the USGS Multi-Resolution Land Characteristics Consortium (MRLC).
- 3. AERMOD version

Results

Pollutant	Averaging Period	Receptor Type	Maximum Receptor ID	UTM E (m)	UTM N (m)	Modeled Concentration (µg/m³)
EO	Period	Commercial/Industrial	D257	734,328.2	3,746,286.7	0.0022
		Residential/Sensitive	D167	734,078.2	3,746,836.7	0.0005

Model Input Parameters for On-Site Buildings

Model ID	UTM E ¹ (m)	UTM N ¹ (m)	Elevation ² (m)	Building Height	
				(ft)	(m)
BUD111	734,217.7	3,746,444.6	251.01	17	5.18
	734,264.5	3,746,393.1			
	734,399.2	3,746,317.5			
	734,370.0	3,746,263.8			
	734,236.0	3,746,338.7			
	734,242.6	3,746,351.1			
	734,239.3	3,746,354.0			
	734,231.3	3,746,344.9			
	734,224.7	3,746,350.0			
	734,221.8	3,746,347.4			
BUD112	734,195.5	3,746,371.9	250.87	25	7.62
	734,168.4	3,746,403.0			
	734,168.4	3,746,403.0			
	734,217.7	3,746,444.6			
	734,217.7	3,746,444.6			
	734,264.5	3,746,393.1			
	734,399.2	3,746,317.5			
	734,370.0	3,746,263.8			
	734,236.0	3,746,338.7			
	734,242.6	3,746,351.1			
BUD113	734,231.3	3,746,344.9	251.58	68	20.73
	734,239.3	3,746,354.0			
	734,224.7	3,746,350.0			
	734,221.8	3,746,347.4			
	734,172.3	3,746,406.0			
	734,257.9	3,746,379.5			
	734,250.5	3,746,385.1			
	734,255.5	3,746,391.8	251.58	68	20.73
	734,261.5	3,746,387.7			
	734,257.9	3,746,379.5			

Notes:
1. Coordinates reflect UTM MADS3, Zone 16.
2. Modified elevations were incorporated using AERMAP v.180181. Terrain elevation data was obtained using the National Elevation Data (NED) files from the USGS Multi-Resolution Land Characteristics Consortium (MRLC).

Model Input Parameters for Nearby Buildings





Model ID	UTM E ¹ (m)	UTM N ¹ (m)	Elevation ² (m)	Building Height	
				(ft)	(m)
NORTH1	734,335.3	3,746,507.2	254.75	23.6	7.19
	734,301.6	3,746,458.0			
	734,263.8	3,746,485.7			
	734,296.7	3,746,516.1			
NORTH2	734,341.4	3,746,505.1	254.98	25.3	7.71
	734,303.4	3,746,446.8			
	734,446.0	3,746,389.2			
	734,470.9	3,746,452.2			
	734,341.4	3,746,505.1			
EAST	734,474.7	3,746,363.3	253.63	22.6	6.89
	734,508.3	3,746,330.3			
	734,458.1	3,746,280.4			
	734,433.9	3,746,264.5			
	734,410.6	3,746,333.7			
	734,458.1	3,746,347.2			
	734,474.7	3,746,363.3			

Notes:

- 1. Coordinates reflect UTM NAD83, Zone 16.
- 2. Modeled elevations were incorporated using AERMAP 18081. Terrain elevation data was obtained using the National Elevation Data (NED) files from the USGS Multi-Resolution Land Characteristics Consortium (MRLC).

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
1. IDENTIFICATION OF THE SUBSTANCE OR MIXTURE AND OF THE SUPPLIER			
1.1. GHS product identifier.	Ethylene Oxide		
Other means of identification.	Oxirane		
1.2. Recommended use and restrictions on use.	<p>Recommended: Chemical intermediate for production of anti-freeze, polyester resins, non-ionic surfactants and specialty solvents; sterilizing agent for controlling microorganisms in health care applications; fumigant for controlling insect infestation in whole and ground spices and cosmetics; sterilization of musical wind instruments.</p> <p>Advised Against: Consumer use.</p>		
1.3. Supplier's details.	<p>Name: ARC Specialty Products c/o Balchem Corporation</p> <p>Address: 52 Sunrise Park Road New Hampton, NY 10958 USA</p> <p>Phone number: +1 845-326-5611</p> <p>Fax number: +1 845-326-5706</p> <p>Internet: www.arcspecialtyproducts.com</p> <p>Email: sds@balchem.com</p>		
1.4. Emergency phone number.	<p>EMERGENCY TELEPHONE (24 hrs. / 7 days per week)</p> <p>In US: CHEMTREC (800) 424-9300 Outside US & Canada: CHEMTREC (703) 527-3887</p>		

2. HAZARDS IDENTIFICATION	
2.1. GHS classification of the substance or mixture and any national or regional information.	<p>Flammable Gas 1 Pressurized Gas (Liquefied Gas) Carcinogen Category 1B Mutagen Category 1B Acute Toxicity Category 3 (Inhalation); Category 4 (oral) Eye Irritant Category 2A Specific Target Organ Toxicity – Single Exposure 3 Skin Irritant 2</p>
2.2. GHS label elements, including precautionary statements.	<p>Product Label Name: ETHYLENE OXIDE Signal Word: DANGER</p> <div style="display: flex; justify-content: space-around; align-items: center;">     </div> <p>Hazard statement:</p> <p>H220: Extremely flammable gas. H280: Contains gas under pressure; may explode if heated H302: Harmful if swallowed H315: Causes skin irritation H319: Causes serious eye irritation H331: Toxic if inhaled H335: May cause respiratory irritation H340: May cause genetic defects</p>

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
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	<p>H350: May cause cancer</p> <p>Precautionary statement:</p> <p>P201: Obtain special instructions before use.</p> <p>P202: Do not handle until all safety precautions have been read and understood.</p> <p>P210: Keep away from heat/sparks/open flames/hot surfaces. — No smoking.</p> <p>P261: Avoid breathing gas/vapours.</p> <p>P264: Wash hands thoroughly after handling.</p> <p>P270: Do not eat, drink or smoke when using this product.</p> <p>P271: Use only outdoors or in a well-ventilated area.</p> <p>P280: Wear protective gloves/protective clothing/ eye protection/face protection.</p> <p>P281: Use personal protective equipment as required.</p> <p>P301;P312: IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.</p> <p>P330: Rinse mouth.</p> <p>P302;P352: IF ON SKIN: Wash with plenty of soap and water.</p> <p>P362: Take off contaminated clothing and wash before reuse.</p> <p>P332;P313: If skin irritation occurs: Get medical advice/attention.</p> <p>P304;P340: IF INHALED: Remove person to fresh air and keep comfortable for breathing.</p> <p>P305;P351;P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.</p> <p>P337;P313: If eye irritation persists: Get medical advice/attention.</p> <p>P312: Call a POISON CENTER or doctor/physician if you feel unwell.</p> <p>P308;P313: IF exposed or concerned: Get medical advice/attention.</p> <p>P321: Specific treatment: See first aid section of SDS.</p> <p>P377: Leaking gas fire: Do not extinguish, unless leak can be stopped safely.</p> <p>P381: Eliminate all ignition sources if safe to do so.</p> <p>P403;P233: Store in a well-ventilated</p>
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SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
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	<p>P405: P410;P403:</p> <p>P501:</p>	<p>place. Keep container tightly closed. Store locked up. Protect from sunlight. Store in a well-ventilated place. Dispose of contents/container in accordance with local/regional/national/international regulation.</p>
2.3. Other hazards which do not result in classification or are not covered by the GHS.	EUH006:	Explosive with or without contact with air.

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substance:

Chemical identity.	Ethylene Oxide
Common name, synonyms, etc.	Oxirane, EO, EtO, Dihydroxirene, 1-2 Epoxyethane, Dimethylene Oxide, Oxane, Oxirane, Alpha/Beta-Oxidoethane, Oxacyclopropane
CAS number, EC number, etc.	CAS#: 75-21-8; EC#: 200-849-9 (from EINECS) Chemical Family: Epoxide Formula: (CH ₂) ₂ O Molecular Weight: 44.053 g/mol
Impurities and stabilizing additives which are themselves classified and which contribute to the classification of the substance.	Contains no other components or impurities which will influence the classification of the product.

3.2. Mixture:

The chemical identity and concentration or concentration ranges of all ingredients which are hazardous within the meaning of the GHS and are present above their cutoff levels.	Chemical Identity:	Concentration:	CAS No.:
	No applicable information found (i.e. material is not a mixture).		

4. FIRST AID MEASURES

4.1. Description of first aid measures.	<p>EYE CONTACT: Immediately flush eyes, including the entire surface of the eyes and under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Obtain medical attention immediately. NOTE: Never wear contact lenses when working with ethylene oxide.</p> <p>SKIN CONTACT: Immediately flush skin thoroughly with water for at least 15 minutes while removing contaminated clothing and shoes. Obtain medical attention immediately. Treat for possible cryogenic injury, if needed by warming affected areas with tepid water (wrap with a blanket if lukewarm water is not available). Wash clothing before reuse and discard contaminated leather articles such as shoes and belts.</p> <p>INHALATION: Remove exposed person to fresh air. If</p>
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SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
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	<p>breathing has stopped, give artificial respiration then have qualified personnel administer oxygen, if needed. Get immediate medical attention.</p> <p><u>INGESTION:</u> If patient is conscious give plenty of water (minimum of two glasses) but DO NOT INDUCE VOMITING. This material is corrosive. Keep head lower than hips to avoid aspiration, should vomiting occur. Get medical attention immediately.</p> <p><u>MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:</u> Preexisting skin, eye and respiratory disorders; lung, blood, nervous system and peripheral nerve disorders.</p>
4.2. Most important symptoms/effects.	<p><u>SIGNS AND SYMPTOMS OF OVEREXPOSURE:</u> Effects include skin, eye and respiratory tract irritation or burns. Central nervous system effects initially cause headache, dizziness and nausea and in extreme cases, unconsciousness and death. Peripheral nerve damage may result in muscular weakness, giddiness, irrational behavior and loss of sensation in the extremities. Dulling of the sense of smell may occur.</p>
4.3. Indication of immediate medical attention and special treatment needed, if necessary.	<p><u>NOTE TO PHYSICIANS:</u> Respiratory symptoms include nausea, vomiting and irritation of the nose and throat. Pulmonary edema may occur. Respiratory effects may be delayed. Consider oxygen administration. If a chemical burn is present, decontaminate skin and treat as any thermal burn. No specific antidote is known, however consider gastric lavage and administration of a charcoal slurry.</p>

5. FIREFIGHTING MEASURES	
5.1. Suitable (and unsuitable) extinguishing media.	<p><u>EXTINGUISHING MEDIA:</u> Carbon dioxide, dry chemical or water spray for small fires. Water spray, polymer or alcohol resistant foams for large fires. Dilution of liquid ethylene oxide with 22 volumes of water should render it non-flammable. Dilution with 100 parts water to one part of ethylene oxide vapor may be required to control build up of flammable vapors in closed systems. Water spray can be used to reduce flame intensity, cool fire-exposed containers and dilute spills to render non-flammable.</p>
5.2. Specific hazards arising from the chemical.	<p><u>EMERGENCY OVERVIEW:</u> Colorless liquid or heavier-than-air gas with a sweet, ether-like odor. Extremely flammable liquefied gas which burns in the absence of oxygen and can explode when exposed to elevated temperatures. Toxic when inhaled. Causes severe skin and eye irritation or burns and respiratory tract irritation; effects may be delayed. Harmful if swallowed or absorbed through the skin. Contact with liquid may cause frostbite.</p> <p><u>Statement of Hazards:</u> DANGER! Extremely flammable</p>

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
<p>liquid and gas under pressure. May form explosive mixtures with air. Highly Reactive. Harmful or fatal if inhaled and may cause delayed lung injury, respiratory system and nervous system damage. Inhalation may cause dizziness or drowsiness. Liquid contact may cause frostbite. May cause allergic skin reaction. Harmful if swallowed. May cause adverse blood effects, liver and kidney damage based on animal data. Cancer and reproductive hazard.</p> <p>HAZARD RATINGS: (0 = minimum; 4 = maximum)</p> <p><u>HMIS Rating:</u> Health = 3 Flammability = 4 Reactivity = 3 Personal Protection Code = X (Consult your supervisor or standard operating procedures for special handling directions.)</p> <p><u>NFPA Rating:</u> Health = 3 Flammability = 4 Reactivity = 3</p> <p><u>UNUSUAL FIRE AND EXPLOSION HAZARDS:</u> Ethylene oxide is dangerously explosive under fire conditions; it is flammable over an extremely large range of concentrations in air and burns in the absence of oxygen. Liquid ethylene oxide is lighter than water (floats) and vapors are heavier than air and may travel along ground long distances to sources of ignition, and then flash back. Avoid storage at warm temperatures [around 100 °F (38 °C)] in order to prevent polymerization. Do not store at temperatures above 125 °F (52 °C) under any circumstances. Containers are fitted with metallic plugs which melt and release contents when temperature increases to a range of 157-170 °F (69-77 °C). Vapors are extremely flammable and are readily ignited by static charge, sparks and flames at concentrations above 2.6%.</p>			

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
----------------------------	-------------	-----	--------------

5.3. Special protective equipment and precautions for firefighters.	<p>SPECIAL FIRE-FIGHTING PROCEDURES: Wear NIOSH-approved self-contained breathing apparatus (SCBA) operated in the pressure-demand mode and full chemical-resistant protective clothing. Evacuate all personnel from danger area and keep upwind. Immediately cool containers with water spray from maximum safe distance. Stop flow of gas, if without risk, while continuously cooling containers with water. Do not extinguish flames unless flow is stopped, since explosive re-ignition can occur. Remove containers from fire area, if without risk. Refer to the most current edition of the "North American Emergency Response Guidebook" for isolation and evacuation distances.</p>
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6. ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures.	<p>PRECAUTIONS: Treat any ethylene oxide leak as an emergency. All cleanup personnel must wear full protective equipment. Evacuate all personnel from the area except those directly engaged in stopping the leak or in cleaning up.</p>
6.2. Environmental precautions.	<p>ENVIRONMENTAL: Dike runoff water, if possible, to prevent contaminated water from entering sewers, ditches, streams and ponds. It is mandatory to call the National Response Center (800-424-8802) if 10 pounds (4.54 kg) or more is spilled or released to the environment.</p>
6.3. Methods and materials for containment and cleaning up.	<p>SPILL CLEANUP: Eliminate all ignition sources if this can be done safely. Ethylene oxide/air mixtures ignite readily and may detonate. Use water fog or spray to disperse vapors. Flood spill with water spray to dilute and render non-flammable.</p>

7. HANDLING AND STORAGE

7.1. Precautions for safe handling.	<p>HANDLING AND STORAGE PRECAUTIONS: Wear all recommended protective clothing and devices when handling this material. Have established handling and emergency response procedures in place prior to use. Ground and bond shipping container, transfer line, and receiving container. Protect containers from physical damage and regularly inspect them for cracks, leaks or faulty valves.</p>
7.2. Conditions for safe storage, including any incompatibilities.	<p>STORAGE SEGREGATION: Store ethylene oxide in a cool, dry, well-ventilated area away from incompatible chemicals and sources of ignition. Store cylinders and drums upright; secure containers tightly; do not drag or slide; and move in a carefully supervised manner with a suitable hand truck. DO NOT STORE IN DIRECT SUNLIGHT.</p> <p>SHIPPING AND STORAGE CONTAINERS: (See 49 CFR 173.323) Ethylene oxide is shipped and stored in UN 1A1 specification drums and DOT specification drums and cylinders. Nitrogen must be charged into the container after filling with ethylene oxide, bringing the</p>

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
----------------------------	-------------	-----	--------------

	<p>total container pressure up to 50 psig. Before returning container to supplier, pressurize container with nitrogen to 50 psig total pressure; close valves and replace valve plugs tightly in outlets. Check container valves and plugs for leaks prior to shipment. In addition, please refer to the most current edition of NFPA Publication 55, 'Compressed Gases and Cryogenic Fluids Code.'</p> <p>INCOMPATIBILITIES: Ethylene oxide is very reactive. Runaway exothermic polymerization reactions can result from contamination with amines, ammonia, water, acids, bases, metal chlorides, metal oxides, metallic potassium, mercaptans, alcohols, oxidizers and many other organic and inorganic materials.</p>
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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters.	Exposure Limits			
	<u>SOURCE</u>	<u>TWA (8-hr)</u>	<u>STEL (15-min)</u>	<u>OTHER</u>
	OSHA	1 ppm	5 ppm (9 mg/m ³)	0.5 ppm action level (8-hr TWA)
	ACGIH	1 ppm (1.8 mg/m ³)	No applicable information found	800 ppm IDLH
8.2. Appropriate engineering controls.	<p>ENGINEERING CONTROLS: Ethylene oxide, a major fire hazard, can burn in the absence of oxygen. All electrical devices used in areas processing or handling ethylene oxide must be engineered and designed to the applicable local electrical/fire codes. Safeguards can include designing electrical devices as explosion-proof and/or intrinsically safe. When considering engineering controls, users of ethylene oxide should consult the current edition of NFPA 55 (Compressed Gases and Cryogenic Fluids Code, Section 14: Storage, Handling and Use of Ethylene Oxide for Sterilization and Fumigation). Sterilization facilities should consult NIOSH Publication NO. 2007-164 (Alert: Preventing Worker Injuries and Deaths from Explosions in Industrial Ethylene Oxide Sterilization Facilities).</p> <p>VENTILATION: Install and operate general and local exhaust ventilation systems powerful enough to maintain airborne levels of ethylene oxide below the OSHA PEL in the worker's breathing area. Ventilation systems must be of maximum explosion-proof design. Emission controls must be in compliance with Federal, State and local regulations.</p> <p>SAFETY SHOWERS: Have eyewash stations, emergency deluge showers, and washing facilities available in all work areas.</p>			

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
----------------------------	-------------	-----	--------------

	<p>OTHER PROTECTION: Design all engineering systems to be explosion-proof in any area where this gas may be present. Container and system must be electrically grounded/bonded before unloading. Practice good personal hygiene; always wash thoroughly after using this material. Do not eat, drink or smoke in work area.</p>
8.3. Individual protection measures, such as personal protective equipment.	<p>RESPIRATORY PROTECTION: Refer to OSHA respirator regulations cited at 29 CFR 1910.134 and 29 CFR 1910.1047. Wear a NIOSH-approved full facepiece respirator for routine use situations where atmosphere is at or above OSHA's Action Level. Do not exceed the maximum use conditions of the respirator. For emergency or non-routine uses where concentrations are unknown, wear an SCBA with a full facepiece operated in the pressure-demand or positive pressure mode.</p> <p>EYE PROTECTION: Always wear chemical safety glasses. If splashing may occur, wear a full face shield as a supplementary protective measure over safety glasses. NEVER WEAR CONTACT LENSES when working with ethylene oxide.</p> <p>SKIN PROTECTION: Wear impervious gloves (see www.ethyleneoxide.com for permeation data); boots; aprons; head cover; and clean impervious body-covering clothing to prevent any possibility of skin contact. Launder contaminated clothing and discard contaminated leather shoes, belts, etc.</p>

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties.

Appearance (physical state, color, etc.).	Colorless liquid or gas
Corrosivity	Not Corrosive
Odor.	Sweet ether-like
Odor threshold.	261 ppm – detectable 500 to 700 ppm - recognizable
pH.	7, neutral (100 g/L in water)
Melting point/freezing point.	-169 °F (-112 °C)
Initial boiling point and boiling range.	50.7 °F (10.4 °C)
Flash point.	Tag Closed Cup: < 0 °F (< -18 °C)
Evaporation rate.	100% volatile by volume
Flammability (solid, gas).	Flammable
Upper/lower flammability or explosive limits.	Upper flammable limit: 100% vol/vol Lower flammable limit: 2.6% vol/vol
Vapor pressure.	1095 mmHg @ 20 °C
Vapor density.	1.5 (Air = 1)
Relative density.	0.875 at 20 °C
Solubility (ies).	100% in water
Partition coefficient: n-octanol/water.	-0.3
Autoignition temperature.	833 °F (445 °C); Burns in the absence of air
Decomposition temperature.	~932 °F (~773 °K)
Viscosity.	0.255 centipoise at 80 °F

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
Oxidizing properties.		Not an oxidizer	
10. STABILITY AND REACTIVITY			
10.1. Reactivity.		Not reactive under normal conditions. Under abnormal conditions (for example external heating, contamination), thermal decomposition and runaway polymerization can occur and may lead to explosion.	
10.2. Chemical stability.		STABILITY: Material is stable for extended periods in closed, airtight, pressurized containers at room temperature, under normal storage and handling conditions. Vapors may explode when exposed to common ignition sources. In the presence of catalysts, polymerization and decomposition of liquid may occur and is accelerated at temperatures above 800 °F (426 °C).	
10.3. Possibility of hazardous reactions.		HAZARDOUS POLYMERIZATION: Dangerous exothermic polymerization reaction can occur when ethylene oxide is contaminated or when heated.	
10.4. Conditions to avoid (e.g., static discharge, shock or vibration).		CONDITIONS TO AVOID: Avoid storage at warm temperatures [around 100 °F (38 °C)] in order to prevent polymerization. Do not store at temperatures above 125 °F (52 °C) under any circumstances. Avoid contact of ethylene oxide with incompatible chemicals to avoid highly exothermic polymerization reaction. Prevent exposure to all sources of ignition such as heat, flame, lighted tobacco products or electrical or mechanical sparks.	
10.5. Incompatible materials.		See section 7.2	
10.6. Hazardous decomposition products.		HAZARDOUS DECOMPOSITION PRODUCTS: Ethylene oxide undergoes thermal decomposition to form carbon dioxide and carbon monoxide gases.	
11. TOXICOLOGICAL INFORMATION			
11.1. Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact);		PRIMARY ROUTES OF EXPOSURE: Inhalation; eye contact; skin contact/absorption.	
11.2. Symptoms related to the physical, chemical and toxicological characteristics;		ACUTE HEALTH EFFECTS: INHALATION: Inhaling concentrated vapor may cause serious health effects, possibly death. Inhalation may progressively cause mucous membrane and respiratory irritation, headache, vomiting, cyanosis, drowsiness, weakness, loss of coordination, CNS depression, lachrymation, nasal discharge and salivation, gasping, and labored breathing. Delayed effects may include nausea, diarrhea, edema of the lungs, paralysis, convulsions and possibly death. NOTE: Ethylene oxide has a high odor threshold (> 250 ppm) and the sense of smell does not provide adequate protection against its toxic effects. EYE CONTACT: Liquid ethylene oxide is severely irritating and corrosive to the eyes and contact can cause swelling of the conjunctiva and irreversible corneal injury.	

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
	<p>Contact with liquid ethylene oxide can cause frostbite. Vapors may cause eye irritation, tearing, redness and swelling of the conjunctiva.</p> <p>SKIN CONTACT: Prolonged contact with liquid ethylene oxide can cause a local erythema, edema, and formation of blisters. Response is more severe on damp skin. There may be a latency period of several hours prior to the onset of symptoms. Ethylene oxide may be absorbed by the skin, and sustained contact may produce adverse effects such as headache, dizziness, nausea and vomiting. Ethylene oxide is a skin sensitizer and some individuals may suffer an allergic skin reaction. Skin contact may also cause allergic contact dermatitis in some exposed individuals. Liquid ethylene oxide evaporates rapidly and may chill the skin causing frostbite.</p> <p>INGESTION: This relatively unlikely route of exposure is expected to cause severe irritation and burns of the mouth and throat, abdominal pain, nausea, vomiting, collapse and coma. Aspiration may occur during swallowing or vomiting, resulting in lung damage.</p>		
11.3. Delayed and immediate effects and also chronic effects from short- and long-term exposure;	<p>CHRONIC HEALTH EFFECTS:</p> <p>SKIN CONTACT: Long term effects are unknown but are expected to be similar to acute effects of skin exposure.</p> <p>EYE CONTACT: Some cases of cataract formation have been reported.</p> <p>INHALATION: Respiratory irritation which can result in permanent lung injury, chromosomal aberrations and peripheral neurotoxic effects with a numbing of the sense of smell. Cognitive and CNS impairment may result from long term exposures.</p> <p>INGESTION: May cause anemia, gastrointestinal irritation, effects on liver, kidneys, and adrenal glands.</p> <p>CARCINOGENICITY: OSHA classifies ethylene oxide as a cancer/reproductive hazard and considers that, at excessive levels, ethylene oxide may present reproductive, mutagenic, genotoxic, neurologic and skin sensitization hazards. ACGIH classifies ethylene oxide as "A2" - suspected human carcinogen. NTP classifies ethylene oxide as a known human carcinogen. IARC classifies ethylene oxide in Group I (carcinogenic to humans). NIOSH classifies ethylene oxide as a potential human carcinogen.</p>		

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
----------------------------	-------------	-----	--------------

<p>11.4. Numerical measures of toxicity (such as acute toxicity estimates).</p>	<p><u>TOXICOLOGICAL - ACUTE INHALATION:</u> LC₅₀ (1 hr. exposure) 5748 ppm (male rat) 4439 ppm (female rat) 5029 ppm (rat - combined sexes) Various mammalian species exposed to lethal concentrations of ethylene oxide had symptoms of mucous membrane irritation, central nervous system depression, lacrimation, nasal discharge, salivation, nausea, vomiting, diarrhea, respiratory irritation, loss of coordination and convulsions.</p> <p><u>TOXICOLOGICAL - CHRONIC INHALATION:</u> Symptoms of chronic exposure are similar to those observed in acute studies, including lung, kidney and liver damage and testicular tubule degeneration in some species. Studies demonstrated neuromuscular effects as the most sensitive indicator of ethylene oxide overexposure.</p> <p><u>TOXICOLOGICAL - ACUTE DERMAL:</u> No dermal LD₅₀ information is available on this product. It is expected to be corrosive to rabbit skin.</p> <p><u>TOXICOLOGICAL - CHRONIC DERMAL:</u> No chronic dermal toxicity data are available on this product.</p> <p><u>TOXICOLOGICAL - EYE:</u> No eye irritation animal data are available on this product; however, it is expected to be extremely irritating to rabbit eyes.</p> <p><u>TOXICOLOGICAL - ACUTE INGESTION:</u> The acute oral LD₅₀ for this product is: 330 mg/kg, rat.</p> <p><u>TOXICOLOGICAL - CHRONIC INGESTION:</u> The effects of chronic ingestion of this product are unknown.</p> <p><u>CARCINOGENICITY:</u> A recent assessment of available epidemiology studies related to ethylene oxide concluded that the evidence indicates that ethylene oxide does not cause heart disease, an excess of cancers overall, or brain, stomach or pancreatic cancers which were seen in some animal and isolated human studies. The findings with respect to leukemia and non-Hodgkin's lymphoma are less definitive. While the majority of the evidence does not indicate that ethylene oxide causes these cancers, there are some suggestive trends. A longer follow-up of ethylene oxide was completed in 2004 to better clarify these relationships. NIOSH reported no overall elevated risk for any type of cancer or other diseases as compared to the general population, however, among those workers with very high ethylene oxide exposure (combination of exposure level and years worked); there was evidence of an elevated risk for blood</p>
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SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
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	<p>cancers among men and breast cancer among women. Two inhalation studies with rats demonstrated carcinogenic responses consisting of increased incidences of mononuclear cell leukemia, peritoneal mesotheliomas, and primary brain tumors. In 2-year inhalation studies with mice there was evidence of carcinogenic activity as indicated by dose-related incidences of benign or malignant neoplasms of the uterus, mammary gland, and hematopoietic system (lymphoma).</p> <p>MUTAGENICITY: While ethylene oxide has demonstrated, in epidemiological studies with exposed workers, an increased incidence of chromosomal aberrations and sister chromatid exchanges, the relevance of such effects to human health hazard evaluation is currently uncertain. In rodent studies, dose related exposure to ethylene oxide induces increases in numbers of adducts in DNA and hemoglobin. Laboratory studies with mice have shown that acute exposure to ethylene oxide at 300 ppm and above caused testicular injury as evidenced by concentration-related increased embryonic deaths following mating of exposed males to non-exposed females (Dominant-Lethal Test).</p> <p>NEUROTOXICITY: Effects are similar to those of acute (short term) exposure, namely, headaches, nausea, diarrhea, lethargy and irrational behavior. Muscle weakness, loss of sensation in the extremities and a reduction in the sense of smell and/or taste may also result. Studies on workers indicate that CNS and cognitive impairment may result from chronic exposures to ethylene oxide.</p> <p>REPRODUCTIVE EFFECTS: Some limited epidemiological data suggests that women exposed to ethylene oxide have a greater incidence of miscarriage. A one-generation reproduction study in rats showed decreased numbers of pups at 100 ppm but not at 33 ppm. In a two-generation reproduction study involving exposure of rats to ethylene oxide vapor for 6 hrs/day, 5 days/week, there was parental toxicity at 33 ppm and 100 ppm. Post implantation losses with reduction in litter size and offspring body weight were found at 33 ppm and 100 ppm. The no-observable effect concentration for adult toxicity, offspring effect and reproductive effect was 10 ppm.</p> <p>TERATOLOGY: Inhalation development toxicity studies with rats exposed to ethylene oxide vapor at concentrations of 50 ppm, 125 ppm and 225 ppm showed that maternal toxicity occurred at 125 and 225 ppm. Fetotoxicity, evidenced by reduced fetal body weight, occurred at all concentrations. At 225 ppm and</p>
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SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
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	<p>to a lesser extent at 125 ppm an increased incidence of skeletal variants was found. There was no evidence of embryotoxicity or malformations.</p> <p>TARGET ORGANS: Overexposure to this product may affect the skin, eyes, respiratory system, liver, kidneys, brain, blood, reproductive system and central nervous system.</p>
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12. ECOLOGICAL INFORMATION

12.1. Ecotoxicity (aquatic and terrestrial, where available).	<p>AQUATIC TOXICITY: Acute 96-hr. LC₅₀ data: 57-84 mg/L, fathead minnow (<i>Pimephales promelas</i>) 90 mg/L, goldfish (<i>Carassius auratus</i>) 137-300 mg/L, water flea (<i>Daphnia magna</i>) Material is slightly toxic to marine invertebrates. 48 hr. LC₅₀ in brine shrimp: 490 mg/L</p>
12.2. Persistence and degradability.	<p>CHEMICAL FATE INFORMATION: BOD₅: 0.35 p/p. BOD₁₀: 1.1 p/p. BOD₂₀: 1.3 p/p.</p>
12.3. Bioaccumulative potential.	<p>Log octanol/water partition coefficient (log K_{ow}) is low. Partitioning from water to oil is low. Bioconcentration is not expected to occur due to high water solubility and a low log K_{ow}. Ethylene oxide hydrolyzes to ethylene glycol. Biodegradation of ethylene oxide occurs at a moderate rate after acclimation (3-20% degradation after 5 days; 70% after 20 days). Biodegradation is expected in a wastewater treatment plant. Ethylene oxide has an estimated half life in the atmosphere of 105 days. EO does not readily absorb into sediments or soils and does not persist in soils; if absorbed, soil organisms will over time convert EO to glycols eliminating any persistence in the soil.</p>
12.4. Mobility in soil.	EO does not readily absorb into sediments or soils.
12.5. Results of PBT and vPvB	No applicable information found.
12.6. Other adverse effects.	No applicable information found.

13. DISPOSAL CONSIDERATIONS

13.1. Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.	<p>WASTE MANAGEMENT/DISPOSAL: When disposed, ethylene oxide is a RCRA hazardous waste with waste code U115 (Commercial chemical product - listed for toxicity and ignitability). Waste ethylene oxide may be incinerated in an approved hazardous waste incinerator or can be biologically treated in an approved facility. DO NOT INCINERATE ANY ETHYLENE OXIDE CONTAINERS. Ethylene oxide is banned from land disposal. Dispose of waste materials in accordance with all applicable Federal, State and local laws and regulations.</p>
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14. TRANSPORT INFORMATION

14.1. UN number.	UN 1040
14.2. UN proper shipping name.	Ethylene Oxide

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
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14.3. Transport hazard class (es).	<p><u>DOT</u> Primary: 2.3 (Poison Gas); Secondary: 2.1 (Flammable Gas) Poison-Inhalation Hazard Zone D Reportable Quantity 10 lb (4.54 kg)</p> <p><u>IMO</u> Primary: 2.3 (Toxic Gas); Secondary: 2.1 (Flammable Gas)</p> <p><u>TDG (from or within Canada)</u> Primary: 2.3 (Toxic Gas); Secondary: 2.1 (Flammable Gas)</p> <p>Shipments of residual amounts of ethylene oxide are considered hazardous material. All facilities shipping or receiving ethylene oxide are subject to registration as a shipper of hazardous material (49 CFR 107, Subpart G). All facilities handling ethylene oxide must also maintain a written security plan (49 CFR 172.00 – 804, 49 CFR 172.704)</p>
14.4. Packing group, if applicable.	Not applicable
14.5. Marine pollutant (Yes/No).	No
14.6. Special precautions which a user needs to be aware of or needs to comply with in connection with transport or conveyance either within or outside their premises.	See Section 7.2
14.7. Transportation in bulk according to Annex II of MARPOL 73/78 and the IBC Code.	Product is not supplied in bulk

15. REGULATORY INFORMATION

15.1. Safety, health and environmental regulations specific for the product in question.

US Federal:	CERCLA:	Section 103: Reportable Quantity – 10 lb (40 CFR 302.4)
	CWA:	Release into a waterway may require reporting to the National Response Center @ 800-424-8802 (40 CFR 116.4).
	FIFRA	<p>If this chemical is a pesticide product registered by the United States Environmental Protection Agency, it is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets (SDS), and for workplace labels of non-pesticide chemicals. The hazard information required on the pesticide label is reproduced below. The pesticide label also includes other important information, including directions for use.</p> <p><u>EPA Registration No. 36736-2 and EPA Registration No. 36736-8</u> DANGER! Causes eye and skin burns. Harmful if inhaled. May cause nervous system damage. Cancer hazard and reproductive hazard. May be fatal if inhaled in high concentrations. May cause irritation of the respiratory tract. May cause immediate or delayed skin irritation or blisters. May cause allergic skin reaction. Do not breathe vapor. Highly flammable liquid and gas under pressure.</p>
	RCRA:	If discarded in purchased form, this product is a listed and characteristic hazardous waste. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal whether a material containing the product or derived from the product should be classified

SAFETY DATA SHEET

Effective Date: 05-09-2014		Revision: D		ARC		Language: EN	
		as a hazardous waste (40 CFR 261.20-24).					
	RMP:	Listed under the EPA Chemical Accidental Prevention Provisions (Risk Management Plan: 40 CFR 68.130) as a Toxic with a 10000 lb Threshold Quantity					
	SARA TITLE III:	Section 302 Extremely Hazardous Substances – Listed; 1000 lb Threshold Planning Quantity (40 CFR 355 Appendix A) Section 304 – Listed 10 lb Reportable Quantity (40 CFR 302.4) Section 311/312 Hazard Categories – Acute, Chronic, Fire, Reactive, Sudden Release (40 CFR 370.66) Section 313 Toxic Chemicals – Listed (40 CFR 372.65)					
	TSCA:	On TSCA inventory.					
	Other EPA	EPA list of Hazardous Air Contaminants: Listed EPA Organic Hazardous Air Pollutant (HAP) list (40 CFR 61.01): Listed EPA list of Pesticide Chemicals (40 CFR 180.151): Listed EPA NESHAPS (40 CFR 63.360) VOC Rule: 100% VOC					
	FDA/USDA:	Not applicable.					
	OSHA:	This product is hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1910.1200. Ethylene Oxide Standard 29 CFR 1910.1047					
	Other OSHA:	Listed under the Process Safety Management standard (29 CFR 1910.119) with 5000 lb Threshold Quantity.					
US State:	California Proposition 65: Listed; cancer hazard; reproductive hazard California Director's List: Listed Florida Hazardous Substance List: Listed Massachusetts Extraordinarily Hazardous Substance List: Listed Minnesota Hazardous Substance List: Listed New Jersey Hazardous Substance List: Listed sn 0882 (Special Hazardous Substance; Environmental Hazardous Substance) Pennsylvania Right-to-know List: Listed						
Canadian:	DSL:	Listed as Oxirane (published 5 April 1994)					
	WHMIS:	Ingredient Disclosure List: Listed 0.1%, item 725 (1310) Classification: A; B1; D1A; D2A; D2B; F This MSDS complies with the Canadian Controlled Product Regulations.					
EU:	CLP:	This product is not sold into the European Union.					
	EINECS:						
	REACH:						
	Safety Data Sheets:						

16. OTHER INFORMATION INCLUDING INFORMATION ON PREPARATION AND REVISION

Last Revision Date:	See top of each page under 'Effective Date'	
Reason for Issue:	Rev A supersedes Rev. 22 Jul 2009	Reformatted per OSHA GHS. Added part 10.1. Changed 11.4 Acute Ingestion LD50 from 72 to 330 mg/kg (no evidence located to support 72; web review, including IPCS. 2003. Ethylene Oxide. Geneva, World Health Organization, International Program on Chemical Safety, Concise International Chemical Assessment Document 54, p 1-57. http://www.inchem.org/documents/cicads/cicads/cicad54.htm .
	B	Correct flash point temperature from 18°C to -18°C
	C	Remove Canutec phone contact information
	D	Added Corrosivity to section 9 physical and chemical properties to support 29 CFR 1910.119(d)(1)
Risk Phrases Used:	See Section 2.	

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
----------------------------	-------------	-----	--------------

Hazard Ratings:	See Section 5.2
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THE FOLLOWING ABBREVIATIONS MAY BE USED IN THIS DOCUMENT:

ACGIH	American Council of Governmental Industrial Hygienists
AICS	Australian Inventory of Chemical Substances
BOD 5, 10, 20	Biochemical Oxygen Demand, 5, 10 or 20 day
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Classification, Labeling and Packaging
CNS	Central nervous system
CWA	Clean Water Act
D.O.T. or DOT	Department of Transportation
DSL	Domestic Substance List (Canada)
EC ₅₀	Effective concentration which induces a response halfway between the baseline and maximum.
EC	European Community
ECL	Existing Chemicals List (Korea)
EINECS	European Inventory of Existing Commercial Substances
EPA	Environmental Protection Agency
EU	European Union
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
GHS	Globally Harmonized System
HAP	Hazardous Air Pollutant
HMS	Hazardous Materials Information System
IARC	International Agency for Research on Cancer
IBC	International Bulk Chemical Code
IDL	Ingredient disclosure list
IDLH	Immediately Dangerous to Life and Health
IMO	International Maritime Organization
K _{St}	Deflagration Index
LC ₅₀	Median lethal concentration for 50% mortality of subject species by the inhalation route
LD ₅₀	Median lethal dose for 50% mortality of subject species by the oral or dermal route
LD _{Lo}	Median lethal dose low; the lowest dose of a substance introduced by any route other than inhalation reported to have caused death in humans or animals.
LEL / LFL	Lower Explosive Limit / Lower Flammable Limit
MARPOL	International Convention for the Prevention of Pollution from Ships
MSHA	Mine Safety Health Administration
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PBT	Persistent Bioaccumulative Toxic
PEL	Permissible Exposure Limit (default 8 hour day, 40 hour week TWA)
p/p	Parts per part
Ppm	Parts per million
p.s.i.g. or psig	Pounds per square inch (gauge pressure)
PSM	Process Safety Management
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
REACH	Registration, Evaluation, Authorization and Restriction of Chemical Substances

SAFETY DATA SHEET

Effective Date: 05-09-2014	Revision: D	ARC	Language: EN
----------------------------	-------------	-----	--------------

REL	Recommended Exposure Limit (default 10 hour day, 40 hour week TWA)
RMP	Risk Management Plan
SARA	Superfund Amendment and Reauthorization Act of 1990
SCBA	Self-contained breathing apparatus
STEL	Short Term Exposure Limit (default 15 minute TWA)
TDLo	Lowest dose to which humans or animals have been exposed and reported to produce a toxic effect other than cancer
TDG	Transportation of Dangerous Goods
TLV	Threshold limit value
TSCA	Toxic Substance Control Act
TWA	Time Weighted Average
UFL	Upper Flammable Limit
USDA	United States Department of Agriculture
VOC	Volatile organic chemical
vPvB	Very Persistent, Very Bioaccumulative
WHMIS	Workplace Hazardous Material Information System Regulations

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.